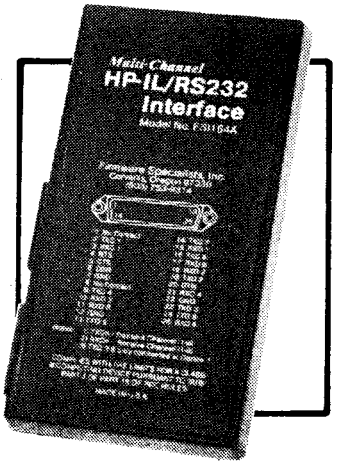

Multi-Channel

HP-IL/RS232 Interface

USER'S MANUAL

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Section 1: GENERAL INFORMATION

Introduction

The Multi-Channel HP-IL/RS232 Interface (Model No. FSI164A) enables you to connect external serial devices that communicate using the RS232 interface standard to a computer that uses the Hewlett Packard Interface Loop (HP-IL)‡ for connection to its peripheral devices. This permits you to use RS232 devices such as modems or serial printers with your HP-41‡, HP-71‡, or HP-75‡ handheld computer.

Comparison To the HP82164A‡ Interface

* Software and hardware compatible
* 2 channels (8 channels optional) instead of 1
* Battery operation (optional)
* Larger buffers
* More flexible handshaking

The FSI164A is very compatible with the Hewlett-Packard HP82164A HP-IL/RS232C Interface. In most applications, it can be substituted with no change of software or connectors. But it is more than just compatible: the FSI164A is more flexible when you take advantage of its expanded hardware and software capabilities.

The most prominent extended feature of the FSI164A is its multi-channel capability. You can switch between 2 (or optionally 8) different RS232 devices using software commands. Only one at a time can be active, but no longer will you need to plug and unplug several peripheral devices.

The low-power design of the FSI164A means that it can be battery-powered. The rechargeable battery option offers built-in battery power that lasts 24 hours or more on a charge (12 hours with 8 channels). The standard unit can be powered by an external 12 volt DC source as well as the supplied AC adapter.

The transmit and receive buffers are about 10 times as large as those in the HP82164A. (More memory for larger buffers is available on a custom order basis. See appendix E.) The size of the buffers can be individually set within the constraints of the installed memory. If you are using the interface with a serial printer, this feature gives you a built-in printer buffer at no extra cost.

There are extensions to the software handshaking capabilities which allow more flexible and efficient system design. See section 2.

The few items of incompatibility with the Hewlett-Packard HP82164A interface are detailed in appendix C.

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Operation In Brief

The diagram on the opposite page shows the FSI164A connected between an HP-IL system and two or more external RS232 devices. The HP-IL system consists of a controller, usually a computer or calculator, and a number of peripheral devices connected in a loop arrangement. The connection between each device is a simple two-wire cable with opposite mating connectors on either end. Information can be transferred in both directions between the controller and any device and also from one device to one or more other devices. The controller must set up each transfer by sending commands to the devices. See the section on detailed operation of the HP-IL for a more complete discussion. The HP-IL interface section of the FSI164A handles the HP-IL signals and converts them to digital signals that the control section can use.

As data is received by the FSI164A from either direction it is stored temporarily in a memory area called a buffer. There is a separate buffer for each direction. Holding the data for a while prevents it from being lost if the communications channel on the other side is not ready to take more data. Information about the contents of the buffers is used by the control section to implement the various "handshaking" schemes that insure the orderly flow of data. The FSI164A is designed with options which allow increasing the total buffer space and changing the ratio of space used for the two directions. (See the ZC command, page 19, and Appendix E.)

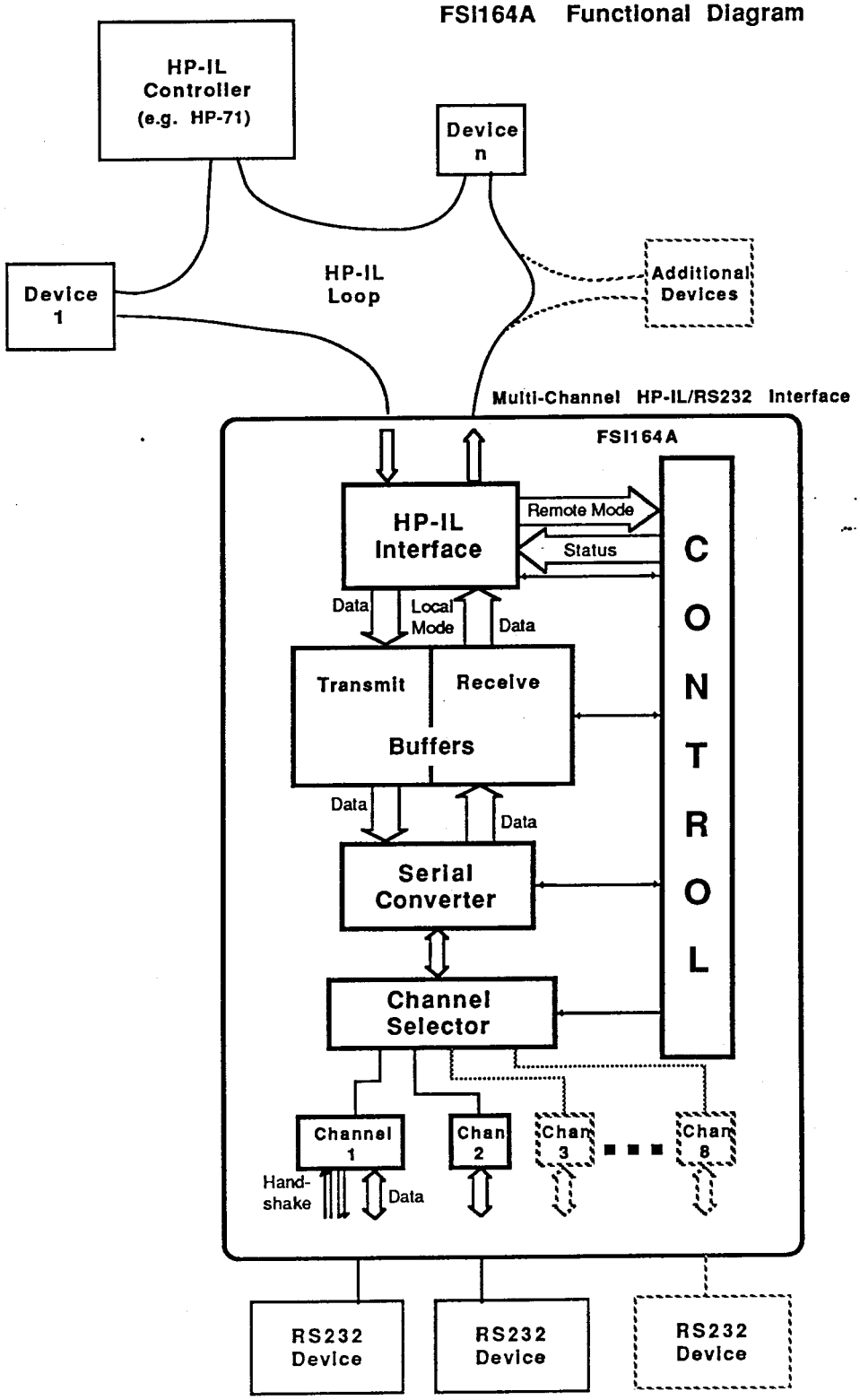
The Serial Interface converts between the 8-bit internal data format and the RS232 serial format where data is transmitted one bit at a time. The channel selector connects this RS232 data channel to the selected external interface. Channel 1 is selected by default when the power is first turned on. Its pin connections are the same as the RS232 signals on the HP82164A.

The two RS232 channel drivers (optionally 8) convert the internal voltage levels of the FSI164A digital circuits to the voltages required by the RS232 standard. There are two groups of signal lines in RS232. Two wires carry the data signals for the two directions. Five other wires carry signals used to control the communications channel. All signals are referenced to a ground wire. Only Channel 1 on the FSI164A has the control lines, and only four of them are implemented. The other seven channels use only the data lines and ground. In most cases this "three-wire connection" is sufficient because software "handshaking" is used to control the flow of data.

The Control section of the FSI164A coordinates the flow of data through the device. It transfers data between the two interfaces and the buffers, monitors the state of the buffers and sees that proper control signals are issued in each direction. In addition it stores information about the operating parameters and communicates with the HP-IL controller to change parameters and to report on the status of the FSI164A. The ability to change most of the operating parameters makes the HP-IL/RS232 interface very versatile and the FSI164A has more versatility than was previously available. See the detailed operation sections for more complete information.

The operating parameters are stored in two sets of registers: the Control Registers numbered R0 through R17 and the Character Registers numbered C0 through C19. The registers can be set directly or read using the HP-IL Device-Dependent Messages. Operating parameters can also be set using the Remote Mode Commands. See the section on Control Structure for details. To simplify reference to these registers in the following sections we will use a convention to refer to the registers and the individual bits in the registers illustrated by the following examples: Control Register 8 = (R8) , Character Register 12 = (C12) , Bits 0 and 1 of Control Register 14 = (R14-0,1).

FSI164A Functional Diagram



Installation

1. Connect the FSI164A to the RS232 peripheral using the proper cable. Refer to the following section on the RS232 for details about how to make the correct connections. Most standard RS232 cables will work with channel 1, which is selected when you turn on the FSI164A.

2. Use the supplied cable to connect the FSI164A into the HP-IL loop. The ends are shaped so that it is impossible to do it incorrectly.

3. With battery option: See the box below.
   Without battery option: Plug in the AC adapter and connect it to the FSI164A. The unit will now be on. The red light will blink continuously.

4. With battery option: Turn on the FSI164A by pushing the switch toward the red light. When the unit is working properly, the red light should be continuously blinking.

> If you have the battery option, make sure the switch is off, then connect the AC adapter/recharger. Push the switch away from the red light to turn it off. Let the battery charge for 1/2 hour before turning the FSI164A on using AC power. Let it continue to charge for 24 hours before using it on battery power alone. This insures that all the cells start out in the same fully charged condition. See Appendix A for more information.

Section 2: RS232 OPERATION

Description of the RS232 Standard

The RS232 Standard was specified by the Electronics Industries Association in 1969. Since the standard was made general enough to encompass many of the serial interfaces developed prior to 1969, it is not an exact standard. Thus, any particular RS232 device may not work properly with another RS232 device without some degree of modification. The FSI164A Multi-Channel Interface was designed to allow you to easily make most of these necessary modifications.

RS232 is a serial interfacing method in which data is transmitted one bit at a time over a single transmission line. In the ASCII character set, a character is seven bits long. Bits are added to indicate the start and stop of the character and sometimes a parity bit is added to check the integrity of the transmissions. All the bits (typically 10) for one character form a "frame". Thus it takes 10 consecutive time periods to transmit the character serially whereas a parallel data channel (which uses 8 wires to simultaneously transmit all 8 bits of a character) needs only one. While the parallel arrangement is faster, serial transmission is less expensive, particularly over long distances, since fewer wires are needed.

Equipment Types

RS232 deals with two types of equipment: devices which manipulate data (called Data Terminal Equipment or DTE) and devices which transmit and receive data over a communication channel (called Data Communication Equipment or DCE). Since a computer is often the DTE device and a modem is often the DCE device we will use the terms "computer" and "modem" to refer to the DTE and DCE. types of RS232 devices. The types are distinguished by the connector and the arrangement of signal lines, but the rules about what type of RS232 connector a device with a particular function should have are not rigid. Some serial printers are "modems" (DCE) and some are "computers" (DTE) and some "computer" type devices use the "modem" type connector or *vice-versa*. The arrangement of signals in the connectors is such that a "modem" can be connected directly to a "computer". The modem "listens" on the same connector pins that the computer "talks" on and *vice-versa*. If a computer needs to be connected to another computer or a modem to a modem, it can be done with a cable that switches the appropriate signal wires between the connectors on each end. Cables like this are available commercially. The FSI164A is a "computer". It can not be changed into a "modem" with an internal jumper as the HP82164A can, but standard cable adapters can be obtained to accomplish the same effect.

Signal Lines

The RS232 signal lines and pin assignments for the FSI164A Multi- Channel HP-IL/RS232 Interface are listed in the table on page 9. The interface is configured as Data Terminal Equipment and all lines are defined from that perspective. The connection to the pins of the RS232 connector are also given in a diagram on page 9.

"Handshaking"

Getting data from one place to another without losing some of it requires that the transmitter know that the receiver is ready to accept the data to be sent. There are several ways to do that, and the process is known as "handshaking". The FSI164A can be set up to work with all the most common schemes. When it is turned on, it will not do any handshaking: the options must be specifically set. The following paragraphs and the section on Control Structure tell you how to do it.

Hardware handshaking uses the voltages on several of the wires in the RS232 connector to signal readiness to take data for each direction of data flow. Some devices can maintain the flow of data in both directions simultaneously (full-duplex) while some can only communicate in one direction at a time (half-duplex). The hardware handshake functions slightly differently in the two modes. The FSI164A is a full-duplex device, but it can be set to respond appropriately when communicating with a half-duplex device.

Software handshaking is another way to insure readiness for data transmission. Special characters are exchanged by transmitter and receiver in a prescribed way so that the transmitter never sends more characters than the receiver is ready to receive. The FSI164A supports the most common handshaking schemes and offers additional flexibility above the standard set by the HP82164A.

Hardware Handshaking

There are 4 wires used for hardware handshaking. The official names are given in the table on page 9, but we will call them Modem On (Data Set Ready), Modem Can Receive (Clear To Send), Computer Ready (Data Terminal Ready), and Computer Has Data (Request To Send).* The non-standard terminology more accurately describes the function and direction of the lines and should make the following discussion a little clearer. Also remember that we are using "computer" to refer to a generic DTE device and "modem" for a DCE, and that the power-on default is no handshaking at all.

FULL-DUPLEX. A complete hardware handshake in full-duplex mode (when the devices can send data in both directions at the same time) is very simple. The FSI164A sets Computer Ready (DTR) and Computer Has Data (RTS) TRUE as soon as it has been turned on and has passed its self-tests. This means it is continually ready to take data. The only interruption of this condition would be an Auto-Disconnect. See that paragraph on page 9. The FSI164A monitors the Modem On (DSR) and Modem Can Receive (CTS) lines and sends data only when they are both TRUE and it has some data to send.

HALF-DUPLEX. The functions of the control lines can be altered to work in half-duplex mode. The Computer Has Data (RTS) and Modem Can Receive (CTS) lines then interact to control the direction of data transfer. As in full-duplex mode, the FSI164A continuously holds its Computer Ready (DTR) line TRUE after the power-on self test. The Modem On (DSR) line must also be TRUE for any data transfer. When the FSI164A has data to send, it sets its Computer Has Data (RTS) line TRUE. If the RS232 device can take the data and has no data of its own to send, it responds by setting its Modem Can Receive (CTS) line TRUE. When the FSI164A detects this condition, it begins to transmit a line of data. When the end of the line is reached (defined by the characters in C2 and C3 -- see page16), the FSI164A briefly drops its ~~Computer Has Data~~ (RTS) line to FALSE to give the RS232 device an opportunity to send some data the other way. The RS232 device will respond by setting ~~Modem Can Receive~~ (CTS) to FALSE. If it has data to send it will keep the line FALSE and begin sending the data. Meanwhile, the FSI164A will have set ~~Computer Has Data~~ (RTS) TRUE, but because the RS232 device is holding ~~Modem Can Receive~~ (CTS) FALSE while it is sending data, the FSI164A will not transmit and will continue to receive the data being sent. As soon as the RS232 device is finished, it will set ~~Modem Can Receive~~ (CTS) TRUE and the process can repeat for another line of data. If the RS232 device has no data to send, it immediately sets

* The HP82164A has a fifth hardware control line, Ring Line Signal Detect, which the FSI164A does not use. All software dealing with this line is implemented, but reacts as if the line were continuously TRUE.

~~Modem Can Receive~~ CTS back to TRUE when ~~Computer Has Data~~ RTS is returned to TRUE following the end-of-line break.

SETTING OPTIONS. Hardware handshakes must be specifically set. The complete full-duplex operation as described above is activated by the Remote Mode Command SL0. Any portion of the handshake can be activated or de-activated by the SL and LI commands. The half-duplex mode is activated by setting bit 0 in Control Register 10 to a value of 1. There is no Remote Mode Command to do this. The states of the output lines can be individually set by the HP-IL controller and the states of the input lines determined (by reading the control registers or activating the newly defined status byte 4 with the ST1 command), allowing complete handshake control by the HP-IL Controller if desired. For more detail see the tables on Remote Mode Commands and Control Registers (pages 18 and 14).

Software Handshaking

The hardware handshake controls the physical data path between the FSI164A and the connected RS232 device. Software handshakes control the flow of data itself and can be implemented anywhere along the data path. They take care of situations such as a remote time-share computer, being accessed through a modem connected to the FSI164A, that is too busy to take data as fast as you can send it. The FSI164A can perform these handshakes in a manner completely under the control of the user.

TRANSMITTER PROTOCOL. In this scheme, a primary device called the Host controls the flow of information to and from a secondary device called the Terminal. Information is sent to the Terminal in blocks of an agreed-upon size. When the Host is ready to send a block, it sends a request or "are you ready" character, ENQ (ASCII 05). When the terminal has enough room for one block, it sends back an answer or "OK I'm ready" character called ACK (ASCII 06). The host then transfers the block of data. The FSI164A adds an additional option. When functioning as terminal in this protocol, it can respond to the request character with an "I'm not ready" character called NAK (ASCII 21), if it is not ready to take data. This will allow the Host to go do something else and check again a little later. All of the characters used in the protocol can be changed by writing to character registers C6, C7, or C14.

The Host is presumed to be always ready to take data, so the Terminal can send data at any time without worrying about the block size. In cases where this is not true, an additional part of the transmitter protocol, the prompt character, can be used. The Terminal is not allowed to send data until it receives a special character called the prompt. Then it sends only one line of data. This arrangement allows the Host to control data flow in the opposite direction as well. If the FSI164A is operating as a Host, the HP-IL controller must supply the prompt character. When the FSI164A functions as Terminal, it interprets a character matching C9 as a prompt character if prompt recognition is enabled by R11-0. Also at the end of the line (specified by C2,C3) it will stop sending and wait for another prompt. If prompt recognition is not set, it sends as much data as it has without waiting or stopping at the end of a line.

RECEIVER PROTOCOL. The device receiving data controls the flow under this protocol. It does so by sending a "not ready" character, usually XOFF (ASCII 19), when it is running out of room to accept data. The transmitting device recognizes this character and stops sending data. When the receiver again has enough room it sends a "ready" character, usually XON (ASCII 17), and the transmitting device resumes the data flow. The characters used by the FSI164A when it is the receiver are in C4 and C5. The FSI164A adds the flexibility to recognize different characters when it is functioning as the transmitter, and these are in C12 and C13. Both sets are initialized to XON, XOFF but can be changed to any other character. Receiver protocol requires full-duplex devices, and both devices can use it at the same time to control the data flow in the two directions.

COMBINED PROTOCOL. Some devices use both protocols at the same time. A Host might send data using the transmitter protocol, and then control the returning data with receiver protocol. The FSI164A can operate in this combined mode (set R11-3,2 to "11") and all options are available.

BUFFER CONTROL. The receiving device using receiver protocol must anticipate a full buffer, because the transmitter may not be able to stop immediately when the not-ready character is sent. The FSI164A sends XOFF when it has 24 bytes of room left. The value is in C10 and can be changed to match the behavior of the RS232 device. As a transmitter, the FSI164A will send a maximum of 3 bytes after it receives an XOFF.

For transmitter protocol, the block size must be specified. It is used in the Host mode to determine the size of the block of data to send, and in the Terminal mode to determine the space that must exist in the buffer before an ACK can be sent. The FSI164A sets this value (stored in C8) to 109 initially, for compatibility with the HP82164A. Since the buffers in the FSI164A are much larger, any value from 1 to 256 can be set and is effective for both Host and Terminal mode. The value 0 specifies a 256-byte block size.

RS232 Transmission Frame Parameters

The arrangement of bits in the "packet" of information that represents one character, and the speed of transmission, can vary considerably. The characteristics of the transmitter and receiver MUST match. The FSI164A can conform to a wide variety of frame specifications. A frame consists of a SPACE (positive voltage level) Start bit, followed by several data bits that actually encode the character, followed sometimes by a parity bit, and ending with one or more MARK (negative voltage level) stop bits. The total length of a frame handled by the FSI164A can vary from 10 to 12 bits depending on the options set.

DATA BITS. The number of bits used to encode the character can be set to 7 or 8. It is initially set to 8, and can be changed by the SW commands or by setting register R6-2,1. Due to hardware constraints, the total frame length must be 10 bits or more. Therefore, if you select 7 data bits you must also select either parity or 2 stop bits.

PARITY. The parity bit can be present or not, and if present can be determined on an EVEN or ODD basis from the data bits, or set unconditionally to 1 (MARK) or 0 (SPACE). The FSI164A normally is set for no parity bit present. See the restrictions explained under the data bits section above. The options can be specified with the P commands or by setting register R8-3,2,1.

STOP BITS. Some RS232 devices require a MARK condition longer than one bit time (the Stop Bits) to separate the characters. Since RS232 is an asynchronous transmission scheme, the idle MARK condition can be any length longer than the required stop bit length. The FSI164A normally transmits and expects only one stop bit, but you can change that to 2 or back to 1 with the SS commands or by setting register R6-3. See the restrictions explained in the data bits section above.

SPEED. The rate at which the bits of a frame are transmitted or received by the FSI164A can vary from 50 bits per second (sometimes called baud) to 9600 bps. An additional non-standard speed of 28,800 bps replaces the 19,200 bps offered by the HP82164A because of hardware constraints. Speed is initially set to 9600 bps, but can be changed by the SB commands or by setting register R7.

End-of-Line Indicators

The FSI164A can process end-of-line characters to correct mismatches between the HP-IL system and the RS232 system. It recognizes the end-of-line marker for one side and replaces it with the marker needed by the other side. It is initially set to do no processing. Register R10-3,2,1 controls the options and they can be set by the LE commands. Refer to the control register table for the details.

Autodisconnect

The FSI164A will completely stop all communications in response to certain conditions on the RS232 link. This action is called autodisconnect and is a response to one of two types of conditions: a hardware handshake line being FALSE or a receiver buffer overflow. Autodisconnect by a handshake line must be specifically enabled (R13) for each line for which it is desired. It is always in effect for receive buffer overflow. Buffer overflow problems can be avoided by setting a lower transmission rate. When autodisconnect occurs, communication on both the HP-IL and RS232 stops, both buffers are cleared, and handshake lines are set to FALSE unless they are set to a constant value by the Controller. The autodisconnect state is cleared by sending HP-IL commands Device Clear or Selected Device Clear or by turning power off and on again.

The Extra Channels

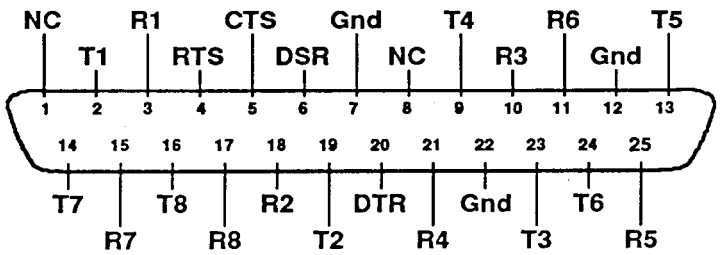
The multi-channel feature of the FSI164A is accessed by the CS Remote Mode Commands or Control Register R15. Only one channel at a time can be selected, and selecting a channel automatically deactivates any previously selected channel. All the channels have only a 3-wire connection, (transmit, receive, and ground) except channel 1, which has the full 7-wire configuration including the hardware handshake lines.

RS232 Signal Lines

Signal	Full Name	Description	Direction FSI - 232
Tn	Transmitted Data	Transmitted data for Channel n where n=1..8	=>
Rn	Received Data	Received data for Channel n	<=
RTS*	Request to Send	FSI164A says, "Can you take some data?"	=>
CTS*	Clear to Send	RS232 device says, "I'm ready for some data."	<=
DSR*	Data Set Ready	RS232 device says, "I'm on and not busy."	<=
Gnd	Signal Ground	Reference for all signal lines.	<=>
DTR*	Data Terminal Ready	FSI164A says, "I'm ready for data."	=>
NC	No Connection	There is no internal connection to this pin.	

* These control signals are effective for Channel 1 only.

RS232 Connector Wiring



Section 3: HP-IL OPERATION

The HP-IL is an easy-to-use method of connecting devices for medium speed data communications. It is low in cost and designed to be used with battery-operated equipment. The Loop consists of a Controller, usually a computer or calculator, and one or more peripheral devices which may include such things as modems, printers, tape or disk drives, or data-gathering devices such as measurement instruments and barcode readers. The devices are connected in a serial loop. Information is sent always in one direction and is passed from one device to the next until it returns to the device that originated it.

Addresses

The Controller controls the HP-IL by sending commands to the various devices. Some commands are for all the devices in the loop, but others must be directed to specific devices. This is accomplished by having each device respond to a unique "address". The HP-IL standard defines a two-tiered addressing scheme which allows for 31 devices using only primary addresses or up to 961 devices using both primary and secondary addresses. There are special provisions for automatically assigning addresses to the devices in any loop configuration, which the FSI164A fully implements. A command aimed at a particular device includes the address of the device. Only the device whose address is the same as the one in the command will respond to it. All the other devices will merely pass it along to the next device in the loop.

Talkers and Listeners

Data is also transferred between devices in the loop. One and only one "Talker" sends the data and one or more "Listeners" receive the data. The Talker and Listeners are assigned by the Controller, using their addresses. Since there can be only one Talker, assigning a device to be a Talker automatically deactivates any previous Talker assignment. Many of the HP-IL commands are given by making the appropriate device or devices Listeners and then the Controller as Talker sends the command to all devices which are listening.

Messages

Information is sent on the HP-IL in packets called Messages. The Messages can carry commands from the Controller to the devices in the loop, information about device operation back to the Controller, or data between any of the devices on the loop, including the Controller. The following table lists all the HP-IL Messages that the FSI164A will respond to, along with a short description of its response. The condition indicated must be met or it will not respond and will merely pass the Message on to the next device in the loop.

Remote Mode

Data sent to the FSI164A is normally interpreted as characters to be passed on to the RS232 device attached to the other side of the interface. This normal situation is called Local mode. There is a second mode in which data bytes are treated as commands to change the operating conditions. This is called Remote mode. Several of the HP-IL messages control switching between Remote and Local modes. The Remote Mode Commands are listed on page 18.

Response of FSI164A to HP-IL Messages

HP-IL Message	Mnemonic	Condition†	FSI164A Response
COMMAND GROUP			
Auto Address Unconfigure	AAU	-	Address set to default value of 8.
Device Clear	DCL	-	Clears both buffers and sets all registers to their power-on values.
Device Dependent Listener 0-31	DDL	L	}See the table "Responses to Device-Dependent Messages"
Device Dependent Talker 0-31	DDT	T	} in Section 4.
Enable Asynchronous Requests	EAR	-	Allows it* to send Identify-Service Request message when loop is idle.
Enable Listener Not Ready	ELN	-	Allows it to indicate a full transmit buffer by sending a Not Ready For Data message rather than just holding the last data message.
Go To Local	GTL	L	No effect. Use Not Remote Enable to return it to Local Mode.
Interface Clear	IFC	-	Stops being Talker or Listener. Any pending series of messages aborted.
Listen Address 0-30	LAD	A	Becomes Listener. Stops being Talker if in Talk mode. If Remote is enabled, changes to remote mode.
Listen Address 31		-	Same as Unlisten message.
Loop Power Down	LPD	-	No response. Does not clear Enable Asynchronous Response setting.
No Operation	NOP	-	Clears Enable Asynchronous Response setting.
Not Remote Enable	NRE	-	Changes from Remote to Local mode.
Parallel Poll Disable	PPD	L	Will no longer modify Identify messages.
Parallel Poll Enable 0-15	PPE	L	Will now modify Identify messages according to parallel poll rules.
Parallel Poll Unconfigure	PPU	-	Will no longer modify Identify messages.
Remote Enable	REN	-	Will go to Remote mode the next time it is made a Listener.
Secondary Address 0-30	SAD	A	If this follows a Talk or Listen message with a primary address that also matches, it becomes a Talker or Listener.
Selected Device Clear	SDC	L	Clears both buffers and sets all registers to their turn-on values.
Talk Address 0-30	TAD	A	Becomes Talker. Stops listening if Listener. If address does NOT match, it stops being a Talker.
Talk Address 31		-	Same as Untalk.
Unlisten	UNL	-	Stops being a Listener.
Untalk	UNT	-	Stops being a Talker.
READY GROUP			
Auto Address 0-31	AAD		}\
Auto Extend Primary 0-31	AEP		}- Normal function. See ref. 1 in Appendix D for the details
Auto Extend Secondary 0-31	AES		}/ of auto-addressing.
End Of Transmission - Error	ETE	T	Sends this message immediately if HP-IL error check is bad.
End Of Transmission - OK	ETO	T	Sends this message after last data byte or if data transfer interrupted.
Not Ready For Data	NRD	T	Does not send any more data.
		L	IF Enable Listener Not Ready is set, it sends this message when the transmit buffer becomes full.
Ready For Command	RFC	-	No response. Does not pass the message to the next device until it is ready for the next command.
Send Accessory ID	SAI	T	Sends one byte with the value 66.
Send Data	SDA	T	Begins sending data in the receive buffer, control registers or character registers whichever was previously selected.
Send Device ID	SDI	T	Sends these characters in ASCII: FSI164A(CR)(LF)
Send Status	SST	T	Sends four bytes of status information.
IDENTIFY GROUP			
Identify	IDY	-	If it has been set by Parallel Poll Enable, it modifies the message according to the parallel poll rules.

†See the end of the table on the next page.

* In this table "it" always means the FSI164A.

DATA / END GROUP

Data Byte	DAB	T	Sends next data byte.
		L	Accepts data byte and passes to next device. The data goes to the transmit buffer in Local mode, or the controller in Remote mode.
End Byte	END	T	Sends next data byte.
		L	Accepts data and passes to next device. An End-of-Line indicator is sent to the RS232 if authorized.

SERVICE REQUEST

If a Service Request condition has been enabled and that condition exists, it will set the Service Request bit in an Identify, Data, or End message to tell the controller it needs attention.

†Condition Code:

- L Device is a Listener.
- T Device is a Talker.
- A Message address matches device address.
- - None.

Condition must be met or FSI164A does not respond.

Section 4: CONTROL STRUCTURE

The operation of the FSI164A is handled by a control section implemented with a microprocessor. The operating parameters are stored in two sets of registers, the Control Registers R0 through R17 and the Character Registers C0 through C19. When power is first applied, the control section checks the operation of all parts of the FSI164A and then sets the values in these registers to certain initial or "default" values. The control section then uses the parameters stored in the registers to determine how to process the information that flows through the FSI164A and how to respond to external events on both the HP-IL and RS232 sides.

Changing the Operating Parameters

The operation of the FSI164A can be modified by changing the values stored in the registers. There are two ways to change the values, both making use of special features of the HP-IL. New values for all the registers of one type can be sent to the FSI164A using the HP-IL Device-Dependent Messages. This method is quick, particularly if many changes are to be made, but it is "low-level" in the sense that one must work with the individual bits of each register and convert them into the proper characters to send. An easier way to change a few operating parameters is provided by Remote Mode Commands. When a device on the HP-IL is switched into Remote Mode by the Controller, all data sent to the device will be interpreted as control information. The commands themselves are defined by the designers of each individual device.

Remote Mode Command Syntax

The FSI164A Remote Mode Commands consist of several ASCII characters followed by one or more terminator characters. There are two formats for the command characters. Format 1 consists of one or two uppercase characters specifying the command followed by nothing or a single decimal digit giving an option within that command. Spaces and carriage returns are ignored. Format 2 consists of a two-letter command followed by four characters of your choice. All characters are significant in this format: nothing is ignored until the four specified characters are processed. The terminator characters are either semicolon (;) or line feed (LF). Several commands can be sent at the same time by separating them with terminators. Here are some examples:

SL0<LF>
SB8; SW 1 ;P0<LF>
QC<DC2><DC4><CAN><NUL>; C2<LF>

<LF> is the single character Linefeed.
<...> are single ASCII control characters.

New FSI164A Remote Mode Commands

There are several Remote mode commands that set the extended features of the FSI164A. QC sets the new software handshake characters. C5 enables the "not ready" transmitter-protocol response. The ST commands control the form of the fourth status byte. ZC sets the buffer sizes and QZ switches between those set sizes and the default sizes. CS selects the RS232 channel. NR simplifies switching out of remote mode, especially for the HP-41. RV allows you to determine the software revision number.

Tables of Control Information

The following tables list the detailed definitions of the Control and Character Registers, the Remote Mode Commands, The Device-Dependent Messages, and the Status Bytes.

Control Registers

Register	Bit	Default 0=OFF 1=ON	Function when ON
R0	3	0	Master Service Request (SR) control bit Must be ON for any service requests.
	2	0	SR control for RS232 errors: parity, frame, overrun, receive buffer overflow.
	1	0	Unused.
	0	0	Service Request when receive buffer has overflowed and data has been lost.
R1	3	0	Service Request when receive buffer is full.
	2	0	Service Request when receive buffer has some data (not empty).
	1	0	Service Request when transmit buffer has some room (not full).
	0	0	Service Request when transmit buffer is empty.
R2	3	0	Unused.
	2	0	Unused by FSI164A. (In the HP82164A it enables the manual SR button.)
	1	0	Service Request when the interface has done an Auto-disconnect.
	0	0	Service Request when a break signal is received from the external device.
R3	3	0	Unused.
	2	0	Delete DEL character (ASCII 128) from received data.
	1	0	Delete NUL character (ASCII 0) from received data.
	0	0	Delete character in C11 from received data.
R4	3	1	DTR line held at value in bit 1. Does handshake when OFF.
	2	1	RTS line held at value in bit 0. Does handshake when OFF.
	1	1	Constant value for Data Terminal Ready line.
	0	1	Constant value for Request To Send line.
R5	3	0	Unused.
	2	0	When read, gives state of Data Set Ready input line. Writing has no effect.
	1	1	Always 1. (HP82164A indicates state of RLSD input line.)
	0	0	When read, gives state of Clear To Send input line. Writing has no effect.
R6	3	0	Number of RS232 stop bits transmitted or expected when receiving. 0 = 1 stop bit 1 = 2 stop bits
	2	0	} Bits 2 and 1 together determine the number of data bits:
	1	0	} (2,1) = 00 = 8 bits 01 = 7 bits (parity or 2 stop bits required)
	0	0	Parity errors in received data are indicated by setting eighth bit (bit 07) in HP-IL data word. Requires that data be 7-bit. If RS232 data word length is set to 8, the eighth (MSB) bit must be 0. R8-1 must be ON for this to function.
R7	3	1	} All 4 bits together determine the Bit Transmission Rate:
	2	1	} (3,2,1,0) = 0000 = 0 bps (will not transmit or receive).
	1	1	} 0001 = 50 bps 0110 = 300 bps 1011 = 3600 bps
	0	0	} 0010 = 75 bps 0111 = 600 bps 1100 = 4800 bps
			0011 = 110 bps 1000 = 1200 bps 1101 = 7200 bps
			0100 = 135 bps 1001 = 1800 bps 1110 = 9600 bps (default)
			0101 = 150 bps 1010 = 2400 bps 1111 = 28800 bps *
			*HP82164A gives 19200 bps

More Control Registers

R8	3	0	} Bits 3 and 2 together determine parity option:
	2	0	} (3,2) = 00 = Odd 10 = Always 1 01 = Even 11 = Always 0
	1	0	Parity bit is present when 1.
	0	0	Characters received from RS232 are immediately sent back out on RS232 (echo). When echo is turned on, the Controller should not send data to FSI164A when it is receiving.
R9	3	0	Transmit break signal. When this bit is set to 1, the FSI164A suspends data transmission on the RS232 and sets the transmit line (pin 2) to the high-voltage, logical 0, state.
	2	1	Ignore Data Set Ready input line.
	1	1	Unused. (HP82164A uses this to ignore RLSD.)
	0	1	Ignore Clear To Send input line.
R10	3	0	Convert end-of-line characters (specified by C0 and C1) received on RS232 to an HP-IL End Byte message.
	2	0	Convert HP-IL End Byte message to end-of-line characters (specified by C2, C3) on RS232.
	1	0	Convert RS232 end-of-line (C0,C1) to end-of-line (C2,C3) on HP-IL with End Byte message. Bit 3 must be "1".
	0	0	RTS output line functions in Half-Duplex mode. Full-Duplex when OFF.
R11	3	1	Receiver protocol (software handshake). Characters defined by C4 and C5.
	2	1	Transmitter protocol (software handshake). Characters C6 and C7.
	1	0	Transmitter protocol option. 0=Terminal 1=Host
	0	0	Use prompt (C9) with Transmitter/Terminal protocol. Must have bit 2=1 and bit1=0.
R12	3	0	Send NULs after any end-of-line (C2,C3) sent to RS232.
	2	0	} Bits 2, 1, and 0 together determine the number of NULs to send.
	1	0	} (2,1,0) = 000 = 1 010 = 3 100 = 5 110 = 7
	0	0	} 001 = 2 011 = 4 101 = 6 111 = 8
R13	3	0	Unused.
	2	0	Auto-Disconnect when Data Set Ready is FALSE (low voltage level).
	1	0	Unused by FSI164A. (In the HP82164A it enables Auto-disconnect when RSLD is FALSE.)
	0	0	Auto-Disconnect when Clear To Send is FALSE (low voltage level).
R14	3	0	Send NAK (C14) in response to ENQ (transmitter protocol) when not ready. If the bit value is 0, it waits until ready, then sends ACK.
	2	0	Unused.
	1	0	Send fourth status byte instead of a zero byte.
	0	0	Unused.
R15	3	0	} All 4 bits together determine the RS232 channel for sending and receiving.
	2	0	} (3,2,1,0) = 0001 = channel 1 0100 = channel 4 0111 = channel 7
	1	0	} 0010 = channel 2 0101 = channel 5 1000 = channel 8
	0	1	} 0011 = channel 3 0110 = channel 6
R16	3	1	Specifies range of installed memory. 1 = 2k bytes 0 = more than 2k bytes.
	2	0	} Bits 2, 1, and 0 together specify the amount of extra memory installed.
	1	0	} (2,1,0) = 001 = 8k 011 = 24k 101 = 40k
	0	0	} 010 = 16k 100 = 32k 110 = 48k
R17	all	0	Reserved for future use.

Character Registers

Register	Default Char	Default Code	Control Bits	Description
C0	CR	13	R10-3	First end-of-line character for deletion. If there is only one character in the sequence, this register should be zero.
C1	LF	10	R10-3	Second end-of-line character for deletion. A single character should be in this register.
C2	CR	13	R10-2	First end-of-line character for insertion. If there is only one character in the sequence, this register should be zero.
C3	LF	10	R10-2	Second end-of-line character for insertion. A single character should be in this register.
C4	XON	17	R11-3	Ready character sent by FSI164A for receiver protocol.
C5	XOFF	19	R11-3	Not Ready character sent by FSI164A for receiver protocol. The HP82164A uses these for both sending and recognizing. See C12.
C6	ENQ	5	R11-2	Request character for transmitter protocol.
C7	ACK	6	R11-2	Answer "Ready" character for transmitter protocol.
C8	j	106	R11-2	Block size for transmitter protocol.
C9	DC1	17	R11-0	Prompt character for transmitter/terminal protocol.
C10	CAN	24	R11-3	Reserved block size for receiver protocol.
C11	DC1	17	R3-0	Specifiable character to be deleted from received RS232 data.
C12	XON	17	R11-3	Ready character recognized by FSI164A for receiver protocol.
C13	XOFF	19	R11-3	Not Ready character recognized by FSI164A for receiver protocol. See C4 and C5.
C14	NAK	21		Answer "Not Ready" character for transmitter protocol.
C15		0		Reserved for future use.
C16		3	R16	C16 and C17 together hold a 16-bit binary number which specifies the size of the transmit buffer (characters being sent to RS232). C16 is the most significant byte. The default value, 957 bytes matches the 2K standard memory configuration. The sum of C16-17 and C18-19 must be less than (total bytes of memory - 67). The memory specified by R16 should agree with actual memory installed.
C17		189	R16	
C18		4	R16	C18 and C19 together hold a 16-bit binary number which specifies the size of the receive buffer (characters being sent to HP-IL). The most significant byte is C18. Default values give 1024 bytes. See the description of C16 and C17.
C19		0	R16	

Status Bytes

The current condition of the FSI164A is maintained in a series of status registers which are normally updated whenever the status of the FSI164A changes. In addition, bit 6 in status byte 1 and 2 is cleared when the condition causing the service request is cleared, or when the FSI164A sends its system status in response to a Send Status message.

Status byte 1 is the system status byte and can only show one condition at a time. The highest priority condition will be indicated until it is cleared, allowing the next highest priority condition to be indicated. Status bytes 2 and 3 are device status bytes and will show all conditions simultaneously. Status byte 4 is the hardware line status byte and contains the same information as Control Registers R4 and R5, but is easier to access. It is normally sent as all zeros for compatibility with the HP82164A. Use Remote Mode Command ST1 to set it to indicate the values defined in the table. The following tables show the definitions for Status bytes 1-4.

Definition of Status Byte 1

Priority	ByteValue Decimal	Binary s=0/1	HP-IL System Status Messages	Meaning for FSI164A
1	132/196	1s000101	No Room	Autodisconnect occurred
2	138/202	1s001010	Device Condition	Break signal was received on the RS232 since status last sent.
3	131/195	1s000011	Data Error	Received RS232 data has had a parity error or bit pattern error, or has overflowed the receive buffer (HP-IL <= RS232).
4	162/226	1s100010	Ready To Send Data (on HP-IL)	Receive buffer has data in it (HP-IL <= RS232).
5	161/227	1s100001	Ready To Receive Data (on HP-IL)	Transmit buffer is not full (HP-IL => RS232).
6	163/227	1s100011	Not Ready To Receive or Send Data (on HP-IL).	Transmit buffer is full (HP-IL => RS232) and receive buffer is empty (HP-IL <= RS232).

The "s" is the Service Request bit. A "1" means the FSI164A has originated a Service Request on the HP-IL. It is set to "0" when the status is sent to the Controller or the condition causing the request stops.

Definition of Status Bytes 2 - 4

Status Byte	Bit	Condition	Definition
2			
	7	RS232 Parity Error	The FSI164A has detected a parity error on the RS232.
	6	RS232 Frame Error	An RS232 frame with an error in the bit pattern has been received. (Bytes with framing errors are deleted.)
	5	RS232 Data Error	Data has been sent too fast by the RS232 device and has been lost. (Always causes an autodisconnect.)
	4	Receive Buffer Overflow	The receive buffer is full and more data has been received and lost. (HP-IL <= RS232).
	3	Receive Buffer Full	The receive buffer is full. (HP-IL <= RS232).
	2	Receive Buffer Not Empty	The receive buffer has some data in it. (HP-IL <= RS232).
	1	Transmit Buffer Not Full	The transmit buffer has some room in it. (HP-IL => RS232).
	0	Transmit Buffer Empty	The transmit buffer is empty. (HP-IL => RS232).
3			
	7	No Clear To Send Response	Request To Send is false and Clear To Send is true.
	6	Always "0"	HP82164A uses this to indicate Manual Service Request.
	5	Autodisconnect	The FSI164A has discontinued its RS232 communication.
	4	Break Received	The FSI164A has received a break signal since status was last sent to the Controller.
	3	Remote Mode	The FSI164A is operating in Remote mode.
	2	Remote Mode Syntax Error	An error has been detected in the incoming sequence of Remote mode instructions.
	1	No Software Handshake	The software handshake is preventing data transmission.
	0	No Hardware Handshake	The hardware handshake is preventing data transmission.
4			
	7	Data Terminal Ready Enable	The DTR line is held at the value of bit 5.
	6	Request To Send Enable	The RTS line is held at the value of bit 4.
	5	Data Terminal Ready	The Data Terminal Ready line is true.
	4	Request To Send	The Request To Send line is true.
	3	Unused	
	2	Data Set Ready	The Data Set Ready line is true.
	1	Always "1"	
	0	Clear To Send	The Clear To Send line is true.

Remote Mode Commands

Sequence	Definition
Autodisconnect	
AE0	Disable. (R13-2,1,0)
AE1	Enable for Clear To Send false. (R13-0)
AE2	Disable for Clear To Send false. (R13-0)
AE3 #	Enable for Received Line Signal Detect false. (R13-1)
AE4 #	Disable for Received Line Signal Detect false.
AE5	Enable for Data Set Ready false. (R13-2)
AE6	Disable for Data Set Ready false. (R13-2)
AE7	Enable for any line false. (R13-2,1,0)
Break	
B0	Break off. (R9-3)
B1	Break on. (R9-3)
Software Protocol	
C0	No protocol. (R11-3,2,1,0)
C1	Transmitter protocol - terminal. (R11-2,1)
C2	Receiver protocol. (R11-3)
C3	Transmitter protocol - host. (R11-2,1)
C4	Prompt enable. (R11-0)
C5 *	NAK enable for transmitter protocol. (R14-3)
Delete Characters	
DE0	Disable. Do not delete any characters. (R3-2,1,0)
DE1	Enable for DEL (R3-2)
DE2	Disable for DEL (R3-2)
DE3	Enable for NUL (R3-1)
DE4	Disable for NUL (R3-1)
DE5	Enable for selectable character in C11. (R3-0)
DE6	Disable for selectable character. (R3-0)
DE7	Enable for DEL, NUL, selectable character. (R3-2,1,0)
Echo	
EE0	Disable. (R8-0)
EE1	Enable. (R8-0)
Special-Function Characters	
FCwxyz	w specifies the transmitter block size. (C8) x is the prompt character. (C9) y specifies the receiver block size. (C10) z is the delete character. (C11)
EOL Delete and Insert Characters	
LCwxyz	w is the first delete character. (C0) x is the second delete character. (C1) y is the first insert character. (C2) z is the second insert character. (C3)
End-Of-Line Options	
LE0	Disable. Do not replace EOL markers. (R10-3,2,1,0)
LE1	Enable insert on RS232. (R10-2)
LE2	Enable detect and delete from RS232 only. (R10-3)
LE3	Enable insert on HP-IL also. (R10-3,1)
LE4	Enable auto Request To Send. (R10-0)
Signal Line Control	
LI0	Disable. Output lines do handshake. (R4-3,2)
LI1	Set Data Terminal Ready true. (R4-3,1)
LI2	Set Data Terminal Ready false. (R4-3,1)
LI3	Set Request To Send true. (R4-2,0)
LI4	Set Request To Send false. (R4-2,0)
LI5	Disable Data Terminal Ready control. (R4-3)
LI6	Disable Request To Send control. (R4-2)
Send Nulls at EOL	
NE0	Disable. (R12-3)
NEx	Send x nulls. (x = 1 to 8) (R12-3,2,1,0)
Parity	
P0	Even parity. (R8-3,2,1)
P1	Odd parity. (R8-3,2,1)
P2	Always 0. (R8-3,2,1)
P3	Always 1. (R8-3,2,1)
P4	No parity bit is transmitted or expected. (R8-3,2,1)
Software Protocol Control Characters	
PCwxyz	w is the receiver protocol "ready" character when FSI164A is the receiver. (C4) x is the receiver protocol "not ready" character when FSI164A is the receiver. (C5) y is the transmitter protocol request character. (C6) z is the transmitter protocol answer character. (C7)
QCwxyz*	w is the receiver protocol "ready" character when FSI164A is the transmitter. (C12) x is the receiver protocol "not ready" char when FSI164A is the transmitter. (C13) y is the transmitter protocol not ready character. (C14) z is the character stored in C15. (reserved)
Reset Buffer	
R0	Clear transmit buffer.
R1	Clear receive buffer.
Baud Rate	
SB1	50 bps. (R7-3,2,1,0)
SB2	75 bps. (R7-3,2,1,0)
SB3	110 bps. (R7-3,2,1,0)
SB4	135 bps. (R7-3,2,1,0)
SB5	150 bps. (R7-3,2,1,0)
SB6	300 bps. (R7-3,2,1,0)
SB7	600 bps. (R7-3,2,1,0)
SB8	1200 bps. (R7-3,2,1,0)
SB9	1800 bps. (R7-3,2,1,0)
SBA	2400 bps. (R7-3,2,1,0)
SBB	3600 bps. (R7-3,2,1,0)
SBC	4800 bps. (R7-3,2,1,0)
SBD	7200 bps. (R7-3,2,1,0)
SBE	9600 bps. (R7-3,2,1,0)
SBF	28800 bps. (R7-3,2,1,0)
Service Request	
SE0	Disable all. (R0-3,2,1,0; R1-3,2,1,0; R2-3,2,1,0)
SE1	Enable for transmit buffer empty. (R0-3; R1-0)
SE2	Enable for transmit buffer not full. (R0-3; R1-1)
SE3	Enable for receive buffer not empty. (R0-3; R1-2)
SE4	Enable for receive buffer full. (R0-3; R1-3)
SE5	Enable for receive buffer overflow. (R0-3,0)
SE6	Enable for data error. (R0-3,2)
SE7	Enable for break received. (R0-3; R2-0)
SE8	Enable for autodisconnect. (R0-3; R2-1)
SE9 #	Enable for manual service request. (R0-3; R2-2)
Hardware Handshake Lines	
SL0	Observe all input lines. (R9-2,1,0)
SL1	Ignore Clear To Send. (R9-0)
SL2	Observe Clear To Send. (R9-0)
SL3 #	Ignore Received Line Signal Detect. (R9-1)
SL4 #	Observe Received Line Signal Detect. (R9-1)
SL5	Ignore Data Set Ready. (R9-2)
SL6	Observe Data Set Ready. (R9-2)
SL7	Ignore all lines. (R9-2,1,0)

* These commands are additional commands only used with the FSI164A.
# These commands have no effect. They are included for software compatibility with HP82164A.

More Remote Mode Commands

Show Parity Error
- SP0 Disable. (R6-0) DEFAULT
- SP1 Enable. (R6-0)

Send Registers
- SR0 Send control registers
- SR2 Send character registers

Stop Bits
- SS0 1 stop bit. (R6-3) DEFAULT
- SS1 2 stop bits. (R6-3)

Word Length
- SW0 8 bits. (R6-2,1) DEFAULT
- SW1 7 bits. (R6-2,1) See Restrictions p.8

Status Format Options
- ST0 * Make fourth status byte all zeros.
- ST1 * Fourth status byte has status of handshake lines..

Transmit and Receive Queues
- ZCxxyy* xx is the transmit buffer size. (C16,C17)
  yy is the receiver buffer size. (C18,C19)
- QZ0 * Make buffers the default size.
- QZ1 * Make buffers the sizes stored in C17, C18, C19, & C20.

Additional New Commands
- NR * Not Remote. (Generally used with the HP-41, same meaning as HP-IL command NRE)
- RV * Read Software Revision Number.
- CSx * Select Channel x. (x = 1 to 8)

* These commands are additional commands only used with the FSI164A.

Device-Dependent Messages

Another way to set the control and character registers is by using device-dependent messages when the interface is in Local mode. The Device Dependent Listener 0 message is used to write information to the control registers and The Device Dependent Listener 2 messages are used to write to the character registers. Device Dependent Talker 0 and 2 messages are used to read the respective registers. Since the Control Registers are only 4 bits long, The FSI164A adds high-order bits to make the printable characters "0" to "?" (ASCII 48 - 63) to represent the 4-bit range. When the FSI164A receives Control Registers, the high-order bits are ignored, allowing you to send printable characters with the correct low-order bits. A complete table of device-dependent messages is given below.

Responses to Device-Dependent Messages

Message	Name	Interface Response
Device Dependent Listener:		
0	Set Control Registers	Up to 18 subsequent Data Bytes from HP-IL are stored in R0 through R17.
1	Clear Transmit Buffer	Transmit buffer is cleared.
2	Set Character Registers	Up to 20 subsequent Data Bytes from HP-IL are stored in C0 through C19.
3	Break On	Clears the transmit buffer and sends a continuous break signal to the external device on the Transmitted Data line. Continues until a Break Off instruction is received.
4	Break Off	Clears the transmit buffer and deactivates a break signal, enabling data to be sent to the external device.
5 - 31	No response.	
Device Dependent Talker:		
0	Send Control Registers	Subsequent Send Data messages causes the contents of R0 through R17 to be sent on HP-IL (18 data bytes).
1	Clear Receive Buffer	Receive buffer is cleared.
2	Send Character Registers	Subsequent Send Data message causes the contents of C0 through C19 to be sent on HP-IL (20 data bytes).
3 - 31	No response.	

Appendix A:
Care, Warranty and Service Information

Precautions

Only the normal precautions used for any electronic equipment need be observed:

* The FSI164A is NOT waterproof. Keep it out of the weather and away from water or other liquids.
* It is good practice to turn any electronic equipment off before connecting it to other equipment.
* Static discharges can damage any electronic device. If your work area generates static easily, be sure you are discharged to ground before touching the FSI164A. There are antistatic sprays available which can be sprayed on carpet to reduce the problem.

Charging the Battery

If you have the battery option, charge the battery for about 1/2 hour before using the FSI164A. Let it charge for 24 hours before using it on battery power alone.

The battery is charging whenever the AC adapter is plugged in and connected to the FSI164A. A normal full charge requires 12 to 16 hours. Do not leave it charging for more than 24 hours. When the batteries are not fully discharged, it will take less time to bring them to full charge. If necessary, you can obtain a useful charge with a shorter charging time, but you will not get the full operation time on that charge. In general, battery life will be extended by fewer full discharge cycles rather than many partial discharges.

The FSI164A may be operated while the batteries are charging.

Warranty

The FSI164A Multi-Channel HP-IL/RS232 Interface is warranted by Firmware Specialists, Incorporated, against defects in materials and workmanship for ninety (90) days from the date of original purchase. If you sell your unit or give it as a gift, the warranty is automatically transferred to the new owner and remains in effect for the original ninety (90) day period. During the ninety (90) day period, Firmware Specialists, Inc., will, at our option, repair or replace at no charge a product that proves to be defective, provided you return the product, shipping prepaid, to our company headquarters.

What is not covered

This warranty does not apply if the product has been damaged by accident or misuse, or as the result of service or modification by someone other than an authorized representative of Firmware Specialists, Inc. Also not covered: equipment which has been altered, defaced or has had the serial number removed.

No other express or implied warranty is given. The repair and replacement of a Multi-Channel HP-IL/RS232 Interface is your exclusive remedy.

IN NO EVENT SHALL FIRMWARE SPECIALISTS, INCORPORATED, BE LIABLE FOR CONSEQUENTIAL DAMAGES. And in any event, the company's liability shall not exceed the purchase price of the Multi-Channel HP-IL/RS232 Interface.

Obligation to make changes

Products are sold on the basis of specifications applicable at the time of manufacture. Firmware Specialists, Inc. shall have no obligation to modify or update products sold.

Service Information

You must notify Firmware Specialists Inc. of any service requirements before returning a unit for service. If you have any questions concerning warranty or service arrangements, please contact us. After arrangements have been made, products requiring service shall be sent prepaid to the following address:

Firmware Specialists, Inc.
605 NW 5th Street, Suite 2A
Corvallis, OR 97330
(503) 753-9314

In Plain English

If your Multi-Channel HP-IL/RS232 Interface doesn't work within three months after you buy it, send it back and we'll fix or replace it. This doesn't apply if you have damaged it, even by accident, or an unauthorized person has attempted repairs. Please call ahead to make service arrangements.

Appendix B:
FCC Standards on Radio Frequency Interference

The Federal Communications Commission has established standards which limit interference to radio and television reception due to radio frequency energy emitted by computing devices. The FSI164A is a Class B manufacturer verified computing device and the following information is supplied to you in accordance with 47 CRF 15.838.

This equipment generates and uses radio frequency energy. If not installed and used in strict accordance with the installation and operating instructions contained in this manual, the equipment may cause interference with radio and television reception.

The FSI164A has been type-tested and is manufacturer verified to comply with the limits for a Class B computing device in accordance with the specifications of Subpart J of Part 15 FCC Rules, which are designed to provide reasonable protection against radio and television interference in a residential installation.

However, there is no guarantee that interference will not occur in your particular installation. If this interface does cause interference with radio or television reception (which you can check by simply turning the power to the interface on and off to see if the interference goes on and off at the same time), you are encouraged to try one or more of these corrective measures:

* Reorient the receiving antenna of the affected radio or TV.
* Move the FSI164A away from the affected radio or TV.
* Plug your computer system into a different power outlet so that the affected radio or TV is on a different branch circuit.

If necessary, consult the dealer who sold you the interface or an experienced radio/television technician for additional suggestions. You might also find a booklet prepared by the FCC to be helpful. The booklet, entitled "How to Identify and Resolve TV Interference Problems", is available from:

U. S. Government Printing Office
Washington, DC 20402
(Stock Number 004-000-00345-4)

Appendix C:
Differences Between the FSI164A and the HP82164A

HP82164A features not present in the FSI164A.

* The FSI164A does not detect the Received Line Signal Detect RS232 control signal. Software assumes the line is TRUE, but there is no connection.
* There is no Manual Service Request or Reset button. Reset is accomplished by turning the FSI164A off and on again.
* RS232 word lengths of 5 or 6 bits are not supported, and 7 bit words require parity or two stop bits.
* The highest RS232 speed is 28800 bps. 19200 bps is not available.
* Connector pins which are not connected in the HP82164A are used for additional channels in the FSI164A. Thus there is some potential for signal conflicts when a cable is used that has connections to these pins, even though it may work with the HP82164A.
* The FSI164A cannot be reconfigured internally to be a DCE device.

FSI164A additional features and enhancements.

** There are two RS232 channels. (option of 8)
** As the terminal device using transmitter protocol, the FSI164A can send a "not ready" answer, allowing the host to do other things.
** The transmit and receive buffers are about ten times as large.
** The receiver protocol characters can be different for transmitter and receiver.
** The low-power design of the FSI164A allows operation from batteries as well as AC. (optional internal rechargeable battery or external 12VDC.)

Appendix D: References

1. Gerry Kane, Steve Harper, and David Ushijima. THE HP-IL SYSTEM: An introductory Guide to the Hewlett-Packard Interface Loop. OSBORNE/ McGraw-Hill. Berkeley, CA. 106pp.

Appendix E: Custom Modifications

The design of the FSI164A allows a number of features to be changed. Memory can be increased, allowing even larger buffers. The RS232 signal polarity can be reversed for any combination of lines. Other features can also be modified. Contact Firmware Specialists at (503) 753-9314 for more information on custom modification and costs.

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